Express Mail Label No. EL962311594US

PATENT APPLICATION
Docket No. 11675.185

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND
INTERFERENCES

In re application of:		)
	Kevin G. Donohoe et al.	)
Serial No.:	09/651,871	)
Filed:	August 31, 2000	) Art Unit 1765
For:	GAS PULSING FOR ETCH PROFILE CONTROL	)
Confirmation No.:	4467	)
Examiner:	Lan Vinh	)

TRANSMITTAL OF APPEAL BRIEF UNDER 37 C.F.R. § 1.192

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Transmitted herewith in triplicate is a Brief of Appellant for entry in the above-identified application. Appellant has filed a timely Notice of Appeal from the action of the Examiner dated September 24, 2003. Also enclosed are the following:

x A Certificate of Express Mail Under 37 C.F.R. § 1.10

x Credit Card Payment Form PTO-2038 authorizing payment of $330.00 for the filing fee.

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x The Commissioner is hereby authorized to charge payment of any patent application processing fees under 37 CFR 1.17 associated with this communication or credit any overpayment to Deposit Account No. 23-3178. Duplicate copies of this sheet are attached.

Dated this 24th day of November 2003.

Respectfully submitted,

Gregory M. Taylor
Attorney for Appellants
Registration No. 34,263
Customer No. 022901

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Image 1765 AF/CC

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CERTIFICATE OF EXPRESS MAIL UNDER 37 C.F.R. § 1.10

I hereby certify that the following documents are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. § 1.10 in an envelope addressed to: Mail Stop Appeal Brief – Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the 24th day of November 2003.

- Appeal Brief of Appellant
- Credit Card Payment Form PTO-2038 for $330.00
- Transmittal Letter
- Postcard

Respectfully submitted,

Gregory M. Taylor
Attorney for Appellants
Registration No. 34,263
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BRIEF OF APPELLANT

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Appellants, Kevin G. Donohoe and David S. Becker, have filed a timely Notice of Appeal from the action of the Examiner in finally rejecting all of the claims in this application. This brief is being filed under the provisions of 37 C.F.R. § 1.192. The filing fee of $330.00, as set forth in 37 C.F.R. § 1.17(c) is submitted herewith.

REAL PARTY IN INTEREST

The real party in interest is Micron Technology, Inc., by way of assignment from Kevin G. Donohoe and David S. Becker, who are the named inventors and are captioned in the present brief. The assignment documents were recorded at Reel No. 011070, Frame 0097 in the United States Patent and Trademark Office on August 31, 2000.

RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

STATUS OF CLAIMS

Claims 5-8, 10-27, 29-36, and 38-46 are pending and appealed in the present application. Claims 1-4, 9, 28, and 37 have been cancelled.

STATUS OF AMENDMENTS

All amendments have been previously entered.

SUMMARY OF INVENTION

The present invention is directed to a method to control etch profile while etching a microelectronics substrate. The method comprises providing an etch chamber and a microelectronics substrate disposed therein, and pulsing into the etch chamber at least one gas wherein the pulsing imparts a time varying flow rate to the gas for a plurality of periods of the time varying flow rate. The pulsing provides for the alternating steps of etching the microelectronics substrate with the at least one gas, and forming a deposit with the at least one

gas on a side surface of the microelectronics substrate, the deposit preventing additional etching of the side surface of the microelectronics substrate underneath the deposit. The pulsing is applied so that the at least one gas does not reach steady state concentration within the etch chamber in the plurality of periods.

ISSUES

1. Whether claims 5-8, 11-12, 15-26, 41, and 43-44 are anticipated by U.S. Patent No. 5,980,767 to Koshimizu et al. (hereafter "*Koshimizu*").

2. Whether claims 27, 29-30, 35-36, and 38-39 are anticipated by *Koshimizu.*

3. Whether claims 45-46 are anticipated by *Koshimizu.*

4. Whether claims 10, 13, and 14 are unobvious over *Koshimizu* in view of U.S. Patent No. 4,585,516 to Corn et al. (hereafter "*Corn*").

5. Whether claims 31-34 are unobvious over *Koshimizu* in view of *Corn.*

6. Whether claim 40 is unobvious over *Koshimizu* in view of U.S. Patent No. 6,164,295 to Ui et al. (hereafter "*Ui*").

7. Whether claim 42 is unobvious over *Koshimizu* in view of U.S. Patent No. 4,786,352 to Benzing (hereafter "*Benzing*").

GROUPING OF CLAIMS

Claims 5-8, 10-14, 15-26, and 41-44 stand or fall together. Claims 27, 29-30, 35-36, and 38-40 stand or fall together. Claims 45-46 stand or fall together. Claims 31-34 stand or fall together.

ARGUMENT

1. Claims 5-8, 11-12, 15-26, 41, and 43-44 are not Anticipated by *Koshimizu*

Claims 5-8, 11-12, 15-26, 41, and 43-44 stand rejected under 35 U.S.C. § 102(e) as being anticipated by *Koshimizu.* For the reasons that follow, Appellants respectfully submit that claims 5-8, 11-12, 15-26, 41, and 43-44 are not anticipated by *Koshimizu.*

Independent claim 5 recites, *inter alia*:

> wherein said pulsing is applied so that said at least one gas does not reach steady state concentration within said etch chamber in said plurality of periods

and independent claim 41 recites, *inter alia*:

> wherein said pulsing is applied so that said carbon containing polymer gas does not reach steady state concentration within said etch chamber in said plurality of periods.

Figures 12A and 12B of the present application illustrate this non-steady state pulsing. As stated in the specification in the paragraph beginning at page 25, line 21:

> The solid lines in Figs. 12A and 12B do not superimpose with the respective dashed lines. This feature indicates that under these pulsing conditions the medium within the chamber does not reach steady state conditions. As shown by the solid lines in Figs. 12A and 12B, the transition time between state 1 and state 2 conditions is a significant fraction of the period, and the chamber operates under non steady state conditions for approximately all the time. Figures 12A and 12B illustrate an example of fast pulsing conditions in an embodiment of the present invention in which the system does not reach steady state conditions for any of the states 1 or 2.

In contrast, *Koshimizu* teaches pulsing wherein the concentration within the etch chamber reaches steady state at least once in a given plurality of periods. *See Koshimizu*, Figures 50-53. This steady state period is depicted as the period of time when the pulse is level either at its

maximum or minimum. Thus, the limitations of claims 5 and 41 related to non-steady state concentrations are not taught or suggested by *Koshimizu.*

Appellants therefore respectfully submit that claims 5 and 41 are not anticipated by *Koshimizu*. Claims 6-8, 11-12, 15-26, 43, and 44 depend from either claim 5 or claim 41 and include the respective limitations thereof. Therefore, these dependent claims are also not anticipated by *Koshimizu* for at least the foregoing reasons discussed with respect to claims 5 and 41.

Appellants therefore respectfully request that the rejection of claims 5-8, 11-12, 15-26, 41, and 43-44 under 35 U.S.C. § 102(e) be overturned.

2. <u>Claims 27, 29-30, 35-36, and 38-39 are not Anticipated by *Koshimizu*</u>

Claims 27, 29-30, 35-36, and 38-39 stand rejected under 35 U.S.C. § 102(e) as being anticipated by *Koshimizu.* For the reasons that follow, Appellants respectfully submit that claims 27, 29-30, 35-36, and 38-39 are not anticipated by *Koshimizu.*

Independent claim 27 recites, *inter alia*: "wherein said hydrofluorocarbon gas is pulsed in a range from about 0 sccm to about 25 sccm and is at least intermittently at a higher concentration than said fluorocarbon gas." Independent claim 35 recites, *inter alia*: "wherein said etchant gas is at least intermittently at a higher concentration than said polymer forming gas."

Koshimizu does not teach or suggest the above-recited limitations of claims 27 and 35. For example, in Figures 50-53, *Koshimizu* clearly shows that the CF_4 gas is always at an equal or higher concentration than the CHF_3 gas. Appellants therefore respectfully submit that claims 27 and 35 are not anticipated by *Koshimizu.*

Claims 29, 30, 36, 38, and 39 depend from claim 27 or claim 35 and thus include the respective limitations thereof. Therefore, claims 29, 30, 36, 38, and 39 are also not anticipated by *Koshimizu* for at least the foregoing reasons presented with respect to claims 27 and 35.

Appellants therefore respectfully request that the rejection of claims 27, 29-30, 35-36, and 38-39 under 35 U.S.C. § 102(e) be overturned.

3. <u>Claims 45 and 46 are not Anticipated by *Koshimizu*</u>

Claims 45 and 46 stand rejected under 35 U.S.C. § 102(e) as being anticipated by *Koshimizu.* For the reasons that follow, Appellants respectfully submit that claims 45 and 46 are not anticipated by *Koshimizu.*

Independent claim 45 recites, *inter alia*:

> wherein the pulsing enables the selection of flow rates from within a second process window that is larger than the first process window while still providing the desired etch profile in the microelectronics substrate.

Koshimizu does not teach or suggest the above-recited limitation of claim 45. Appellants therefore respectfully submit that claim 45 and dependent claim 46 are not anticipated by *Koshimizu.*

Appellants therefore respectfully request that the rejection of claims 45 and 46 under 35 U.S.C. § 102(e) be overturned.

4. <u>Claims 10, 13, and 14 are Unobvious Over *Koshimizu* in View of *Corn*</u>

Claims 10, 13, and 14 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Koshimizu* in view of *Corn*. For the reasons that follow, Appellants respectfully submit that claims 10, 13, and 14 are unobvious over *Koshimizu* in view of *Corn*.

Claims 10, 13, and 14 depend from claim 5 and include the limitations thereof. As discussed above with respect to claim 5, there is no teaching or suggestion in *Koshimizu* related to the non-steady state concentration recited in claim 5. In addition, there is no teaching or suggestion in *Corn* of such a feature.

Accordingly, claims 10, 13, and 14 would not have been obvious over *Koshimizu* in view of *Corn*. Appellants therefore respectfully request that the rejection of claims 10, 13, and 14 under 35 U.S.C. § 103(a) be overturned.

5. Claims 31-34 are Unobvious Over *Koshimizu* in View of *Corn*

Claims 31-34 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Koshimizu* in view of *Corn*. For the reasons that follow, Appellants respectfully submit that claims 31-34 are unobvious over *Koshimizu* in view of *Corn*.

Independent claim 31 recites, *inter alia*, "wherein said second gas is at least intermittently at a higher concentration than said first gas." *Koshimizu* does not teach or suggest such a feature. For example, in Figures 50-53 *Koshimizu* clearly shows that the CF_4 gas is always at an equal or higher concentration than the CHF_3 gas. In addition, there is no teaching or suggestion in *Corn* of such a feature.

Accordingly, claim 31 would not have been obvious over *Koshimizu* in view of *Corn*. Claims 32-34 depend from claim 31 and thus include the limitations thereof. Therefore, claims 32-34 would also not have been obvious over *Koshimizu* in view of *Corn*. Appellants therefore respectfully request that the rejection of claims 31-34 under 35 U.S.C. § 103(a) be overturned.

6. Claim 40 is Unobvious Over *Koshimizu* in View of *Ui*

Claim 40 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Koshimizu* in view of *Ui*. For the reasons that follow, Appellants respectfully submit that claim 40 is unobvious over *Koshimizu* in view of *Ui*.

Claim 40 depends from claim 35 and includes the limitations thereof. As discussed above with respect to claim 35, there is no teaching or suggestion in *Koshimizu* related to the etchant gas being at least intermittently at a higher concentration than the polymer forming gas. In addition, there is no teaching or suggestion in *Ui* of such a feature.

Accordingly, claim 40 would not have been obvious over *Koshimizu* in view of *Ui*. Appellants therefore respectfully request that the rejection of claim 40 under 35 U.S.C. § 103(a) be overturned.

7. Claim 42 is Unobvious Over *Koshimizu* in View of *Benzing*

Claim 42 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Koshimizu* in view of *Benzing*. For the reasons that follow, Appellants respectfully submit that claim 42 is unobvious over *Koshimizu* in view of *Benzing*.

Claim 42 depends from claim 41 and includes the limitations thereof. As discussed above with respect to claim 41, there is no teaching or suggestion in *Koshimizu* related to the non-steady state concentration recited in claim 41. In addition, there is no teaching or suggestion in *Benzing* of such a feature.

Accordingly, claim 42 would not have been obvious over *Koshimizu* in view of *Benzing*. Appellants therefore respectfully request that the rejection of claim 42 under 35 U.S.C. § 103(a) be overturned.

In view of the foregoing, Appellants respectfully request the Board to overturn the Examiner's rejections of the appealed claims.

Dated this 24th day of November 2003.

Respectfully submitted,

Gregory M. Taylor
Attorney for Appellants
Registration No. 34,263
Customer No. 022901

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APPENDIX: CLAIMS ON APPEAL

5. A method to control etch profile while etching a microelectronics substrate, the method comprising:

providing an etch chamber and a microelectronics substrate disposed therein; and

pulsing into said etch chamber at least one gas wherein said pulsing imparts a time varying flow rate to said gas for a plurality of periods of said time varying flow rate; wherein the pulsing provides for the alternating steps of:

etching said microelelectronics substrate with said at least one gas; and

forming a deposit with said at least one gas on a side surface of the microelectronics substrate, the deposit preventing additional etching of the side surface of said microelelectronics substrate underneath the deposit;

wherein said pulsing is applied so that said at least one gas does not reach steady state concentration within said etch chamber in said plurality of periods.

6. The method as defined in Claim 5, wherein said etch chamber is associated with a high density etch tool.

7. The method as defined in Claim 5, wherein said substrate is selected from the group consisting of an oxide film, a resist, a multi-layer resist, a metal, a metal alloy, an aluminum alloy, a refractory metal, tungsten, an electrical conductor, and at least one polysilicide.

8. The method as defined in Claim 5, wherein said pulsing is applied so that said at least one gas reaches steady state concentration within said etch chamber in at least one of said plurality of periods.

10. The method as defined in Claim 5, wherein said pulsing is applied at a duty cycle range selected from the group consisting of:

from about 20% to about 80% duty cycle;

from about 30% to about 70% duty cycle; and

from about 40% to about 60% duty cycle.

11. The method as defined in Claim 5, wherein said at least one gas comprises a gas selected from the group consisting of CHF_3, CH_2F_2, a halogenated hydrocarbon, a hydrofluorocarbon, CO, CO_2, O_2, Ar, a fluorocarbon, CF_4, C_4F_8, C_5F_8, BCl_3, Cl_2.

12. The method as defined in Claim 5, further comprising flowing a second gas comprising at least one of the gases nitrogen, oxygen and an inert gas into said etch chamber.

13. The method as defined in Claim 5, wherein said time varying flow rate varying within a range selected from the group consisting of:

between a high flow rate value of about 30 sccm to a low flow rate value of about 15 sccm;

between a high flow rate value of about 27 sccm to a low flow rate value of about 18 sccm;

between a high flow rate value of about 25 sccm to a low flow rate value of about 20 sccm;

between a low flow rate value of about 20 sccm to a high flow rate value of about 30 sccm; and

between a low flow rate value of about 15 sccm to a high flow rate value of about 20 sccm.

14. The method as defined in Claim 13, wherein each of the high and low flow rate values has about the same time duration.

15. The method as defined in Claim 5, wherein said pulsing is controlled with at least one piezoelectric valve.

16. The method as defined in Claim 5, wherein said etching is a process selected from the group consisting of:

an anisotropic self-aligned contact etch; and

an anisotropic high aspect ratio contact etch, wherein the aspect ratio is at least 4 to 1.

17. The method as defined in Claim 5, further comprising, prior to providing said etch chamber, patterning a layered substrate with a photoresist mask to form said microelectronics substrate.

18. The method as defined in Claim 17, wherein said layered substrate comprises an oxide layer and a nitride layer disposed on a silicon layer.

19. The method as defined in Claim 18, wherein said etching halts on said silicon layer.

20. The method as defined in Claim 5, further comprising flowing an etchant gas into said etch chamber.

21. The method as defined in Claim 20, wherein said etchant gas is selected from the group consisting of a polymer forming gas, an etching gas, and a fluorocarbon.

22. The method as defined in Claim 17, wherein said layered substrate comprises at least an oxide layer; the method further comprising flowing an etchant gas into said etch chamber, wherein said etchant gas selectively removes at least a portion of said oxide layer.

23. The method as defined in Claim 5, wherein:

said gas is a protective layer forming gas, wherein the protective layer comprises a polymer;

said microelectronics substrate has at least an oxide layer; and

said gas selectively removes at least a portion of said oxide layer and a vertical profile in said oxide layer.

24. The method as defined in Claim 23, wherein said oxide layer comprises BPSG.

25. The method as defined in Claim 41, wherein said microelectronics structure includes a nitride layer.

26. The method as defined in Claim 25, wherein said nitride layer is at least one of a silicon nitride layer and a silicon oxynitride layer.

27. A method of etching oxide using a polymer, the method comprising:

disposing a patterned semiconductor substrate in a high density plasma etcher, said substrate comprising a silicon layer with a gate stack structure disposed thereon, said gate stack structure being encapsulated by silicon nitride, and layered with an oxide;

providing a hydrofluorocarbon gas into said high density etcher;

selectively removing portions of said oxide by pulsing a fluorocarbon gas; wherein:

said pulsing imparts a time varying flow rate to said fluorocarbon gas for a plurality of periods of said time varying flow rate, wherein said hydrofluorocarbon gas is pulsed in a range from about 0 sccm to about 25 sccm and is at least intermittently at a higher concentration than said fluorocarbon gas;

said hydrofluorocarbon gas removes portions of said oxide; and

said fluorocarbon gas forms a protective layer; and

wherein the pulsing of said fluorocarbon gas causes said hydrofluorocarbon gas to have cyclical concentrations within said high density etcher.

29. The method as defined in Claim 27, wherein said hydrofluorocarbon gas is pulsed into said high density etcher so that the hydrofluorocarbon gas pulses alternate with the fluorocarbon gas pulses and wherein pulsing said hydrofluorocarbon gas imparts a time varying flow rate to said hydrofluorocarbon gas for a plurality of periods of said time varying flow rate.

30. The method as defined in Claim 29, wherein said hydrofluorocarbon gas is pulsed into said high density etcher with at least one piezoelectric valve.

31. A etching method comprising:

forming a photoresist pattern on a microelectronics substrate that includes both an oxide layer and a nitride layer disposed on a silicon layer;

providing an etch chamber and said microelectronics substrate disposed therein;

pulsing into said etch chamber at least one gas suitable for forming a deposit on at least a portion of said microelectronics substrate, wherein:

said deposit is selected from the group consisting of an oxide film, a resist, a multi-layer resist, a metal, a metal alloy, an aluminum alloy, a refractory metal, tungsten, an electrical conductor, polysilicon, and at least one polysilicide;

said at least one gas comprises a gas selected from the group consisting of a halogenated hydrocarbon, and a fluorocarbon;

said pulsing imparts a time varying flow rate to said gas for a plurality of periods of said time varying flow rate;

said pulsing is applied at a duty cycle range selected from the group consisting of:

from about 20% to about 80% duty cycle;

from about 30% to about 70% duty cycle; and

from about 40% to about 60% duty cycle;

said time varying flow rate varies within a range selected from the group consisting of:

between a high flow rate value of about 30 sccm to a low flow rate value of about 15 sccm;

between a high flow rate value of about 27 sccm to a low flow rate value of about 18 sccm;

between a high flow rate value of about 25 sccm to a low flow rate value of about 20 sccm;

between a high flow rate value of about 20 sccm to a low flow rate value of about 30 sccm; and

between a high flow rate value of about 15 sccm to a low flow rate value of about 20 sccm;

etching said microelelectronics substrate with said a second gas during said pulsing, wherein:

wherein said second gas is at least intermittently at a higher concentration than said first gas;

said etching halts on said silicon layer;

said second gas is selected from the group consisting of a polymer forming gas, a polymer etching gas, and a fluorocarbon; and

said second gas selectively removes at least a portion of said oxide layer.

32. The method as defined in Claim 31, wherein said pulsing is applied so that said at least one gas reaches steady state concentration within said etch chamber in at least one of said plurality of periods.

33. The method as defined in Claim 31, wherein said pulsing is applied so that said at least one gas does not reach steady state concentration within said etch chamber in said plurality of periods.

34. The method as defined in Claim 31, further comprising flowing a gas comprising at least one of the gases nitrogen, oxygen and an inert gas into said etch chamber.

35. An etching method comprising:

exposing a substrate to a plurality of gases, wherein at least one of said gases is pulsed and said pulsing imparts a time varying flow rate to said at least one gas for a plurality of periods of said time varying flow rate; and wherein

at least one of said gases comprises an etchant gas selected from the group consisting of a hydrofluorocarbon and a fluorocarbon; and

at least one of said gases comprises a polymer forming gas for depositing a protective layer, wherein said etchant gas is at least intermittently at a higher concentration than said polymer forming gas.

36. The method as defined in Claim 35, wherein

at least one of said gases comprises a gas that modifies the deposition of said protective layer; and

at least one of said gases comprises an etch modifying gas.

38. The method as defined in Claim 35, wherein said gas for depositing a protective layer comprises one gas for depositing a polymer.

39. The method as defined in Claim 36, wherein said gas that modifies the deposition of a protective layer is selected from the group consisting of CO, CO_2, and O_2.

40. The method as defined in Claim 36, wherein said etch modifying gas is selected from the group consisting of BCl_3 and Cl_2.

41. A method to control etch profile while etching a microelectronics substrate, the method comprising:

providing an etch chamber and a microelectronics substrate disposed therein;

pulsing into said etch chamber a carbon containing polymer gas suitable for:

forming a deposit on at least a portion of said microelectronics substrate; and

etching said microelelectronics substrate;

wherein said pulsing imparts a time varying flow rate to said gas for a plurality of periods of said time varying flow rate, thereby causing said gas to alternately form a deposit on at least a portion of said microelectronics substrate and etch said microelelectronics substrate and wherein said pulsing is applied so that said carbon containing polymer gas does not reach steady state concentration within said etch chamber in said plurality of periods.

42. The method as defined in Claim 5, further comprising flowing nitrogen gas into said etch chamber.

43. The method as defined in Claim 5, wherein said layered substrate comprises a thermal oxide layer disposed on a silicon layer.

44. The method as defined in Claim 43, wherein said etching halts on said thermal oxide layer disposed on said silicon layer.

45. A method to provide increased gas flow rate tolerances while etching a microelectronics substrate, the method comprising:

providing an etch chamber and a microelectronics substrate disposed therein;

providing at least one gas for introduction into the etch chamber, the at least one gas capable of both etching the microelelectronics substrate and forming a deposit on a side surface of the microelectronics substrate, wherein use of the at least one gas at a uniform flow rate provides a desired etch profile in the microelectronics substrate at a flow rate selected within a first process window; and

pulsing into the etch chamber the at least one gas wherein the pulsing imparts a time varying flow rate to the gas for a plurality of periods of the time varying flow rate, wherein the pulsing provides for the alternating steps of:

etching the microelelectronics substrate with the at least one gas; and

forming a deposit with the at least one gas on a side surface of the microelectronics substrate, the deposit preventing additional etching of the side surface of the microelelectronics substrate underneath the deposit;

wherein the pulsing enables the selection of flow rates from within a second process window that is larger than the first process window while still providing the desired etch profile in the microelectronics substrate.

46. The method as defined in Claim 45, wherein the pulsing is applied so that the at least one gas does not reach steady state concentration within the etch chamber in the plurality of periods.

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BRIEF OF APPELLANT

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The real party in interest is Micron Technology, Inc., by way of assignment from Kevin G. Donohoe and David S. Becker, who are the named inventors and are captioned in the present brief. The assignment documents were recorded at Reel No. 011070, Frame 0097 in the United States Patent and Trademark Office on August 31, 2000.

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The present invention is directed to a method to control etch profile while etching a microelectronics substrate. The method comprises providing an etch chamber and a microelectronics substrate disposed therein, and pulsing into the etch chamber at least one gas wherein the pulsing imparts a time varying flow rate to the gas for a plurality of periods of the time varying flow rate. The pulsing provides for the alternating steps of etching the microelectronics substrate with the at least one gas, and forming a deposit with the at least one

gas on a side surface of the microelectronics substrate, the deposit preventing additional etching of the side surface of the microelectronics substrate underneath the deposit. The pulsing is applied so that the at least one gas does not reach steady state concentration within the etch chamber in the plurality of periods.

ISSUES

1. Whether claims 5-8, 11-12, 15-26, 41, and 43-44 are anticipated by U.S. Patent No. 5,980,767 to Koshimizu et al. (hereafter "*Koshimizu*").

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Claims 5-8, 10-14, 15-26, and 41-44 stand or fall together. Claims 27, 29-30, 35-36, and 38-40 stand or fall together. Claims 45-46 stand or fall together. Claims 31-34 stand or fall together.

ARGUMENT

1. <u>Claims 5-8, 11-12, 15-26, 41, and 43-44 are not Anticipated by *Koshimizu*</u>

Claims 5-8, 11-12, 15-26, 41, and 43-44 stand rejected under 35 U.S.C. § 102(e) as being anticipated by *Koshimizu*. For the reasons that follow, Appellants respectfully submit that claims 5-8, 11-12, 15-26, 41, and 43-44 are not anticipated by *Koshimizu*.

Independent claim 5 recites, *inter alia*:

> wherein said pulsing is applied so that said at least one gas does not reach steady state concentration within said etch chamber in said plurality of periods

and independent claim 41 recites, *inter alia*:

> wherein said pulsing is applied so that said carbon containing polymer gas does not reach steady state concentration within said etch chamber in said plurality of periods.

Figures 12A and 12B of the present application illustrate this non-steady state pulsing. As stated in the specification in the paragraph beginning at page 25, line 21:

> The solid lines in Figs. 12A and 12B do not superimpose with the respective dashed lines. This feature indicates that under these pulsing conditions the medium within the chamber does not reach steady state conditions. As shown by the solid lines in Figs. 12A and 12B, the transition time between state 1 and state 2 conditions is a significant fraction of the period, and the chamber operates under non steady state conditions for approximately all the time. Figures 12A and 12B illustrate an example of fast pulsing conditions in an embodiment of the present invention in which the system does not reach steady state conditions for any of the states 1 or 2.

In contrast, *Koshimizu* teaches pulsing wherein the concentration within the etch chamber reaches steady state at least once in a given plurality of periods. *See Koshimizu*, Figures 50-53. This steady state period is depicted as the period of time when the pulse is level either at its

maximum or minimum. Thus, the limitations of claims 5 and 41 related to non-steady state concentrations are not taught or suggested by *Koshimizu.*

Appellants therefore respectfully submit that claims 5 and 41 are not anticipated by *Koshimizu.* Claims 6-8, 11-12, 15-26, 43, and 44 depend from either claim 5 or claim 41 and include the respective limitations thereof. Therefore, these dependent claims are also not anticipated by *Koshimizu* for at least the foregoing reasons discussed with respect to claims 5 and 41.

Appellants therefore respectfully request that the rejection of claims 5-8, 11-12, 15-26, 41, and 43-44 under 35 U.S.C. § 102(e) be overturned.

2. Claims 27, 29-30, 35-36, and 38-39 are not Anticipated by *Koshimizu*

Claims 27, 29-30, 35-36, and 38-39 stand rejected under 35 U.S.C. § 102(e) as being anticipated by *Koshimizu.* For the reasons that follow, Appellants respectfully submit that claims 27, 29-30, 35-36, and 38-39 are not anticipated by *Koshimizu.*

Independent claim 27 recites, *inter alia*: "wherein said hydrofluorocarbon gas is pulsed in a range from about 0 sccm to about 25 sccm and is at least intermittently at a higher concentration than said fluorocarbon gas." Independent claim 35 recites, *inter alia*: "wherein said etchant gas is at least intermittently at a higher concentration than said polymer forming gas."

Koshimizu does not teach or suggest the above-recited limitations of claims 27 and 35. For example, in Figures 50-53, *Koshimizu* clearly shows that the CF_4 gas is always at an equal or higher concentration than the CHF_3 gas. Appellants therefore respectfully submit that claims 27 and 35 are not anticipated by *Koshimizu.*

Claims 29, 30, 36, 38, and 39 depend from claim 27 or claim 35 and thus include the respective limitations thereof. Therefore, claims 29, 30, 36, 38, and 39 are also not anticipated by *Koshimizu* for at least the foregoing reasons presented with respect to claims 27 and 35.

Appellants therefore respectfully request that the rejection of claims 27, 29-30, 35-36, and 38-39 under 35 U.S.C. § 102(e) be overturned.

3. Claims 45 and 46 are not Anticipated by *Koshimizu*

Claims 45 and 46 stand rejected under 35 U.S.C. § 102(e) as being anticipated by *Koshimizu*. For the reasons that follow, Appellants respectfully submit that claims 45 and 46 are not anticipated by *Koshimizu*.

Independent claim 45 recites, *inter alia*:

> wherein the pulsing enables the selection of flow rates from within a second process window that is larger than the first process window while still providing the desired etch profile in the microelectronics substrate.

Koshimizu does not teach or suggest the above-recited limitation of claim 45. Appellants therefore respectfully submit that claim 45 and dependent claim 46 are not anticipated by *Koshimizu*.

Appellants therefore respectfully request that the rejection of claims 45 and 46 under 35 U.S.C. § 102(e) be overturned.

4. Claims 10, 13, and 14 are Unobvious Over *Koshimizu* in View of *Corn*

Claims 10, 13, and 14 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Koshimizu* in view of *Corn*. For the reasons that follow, Appellants respectfully submit that claims 10, 13, and 14 are unobvious over *Koshimizu* in view of *Corn*.

Claims 10, 13, and 14 depend from claim 5 and include the limitations thereof. As discussed above with respect to claim 5, there is no teaching or suggestion in *Koshimizu* related to the non-steady state concentration recited in claim 5. In addition, there is no teaching or suggestion in *Corn* of such a feature.

Accordingly, claims 10, 13, and 14 would not have been obvious over *Koshimizu* in view of *Corn*. Appellants therefore respectfully request that the rejection of claims 10, 13, and 14 under 35 U.S.C. § 103(a) be overturned.

5. Claims 31-34 are Unobvious Over *Koshimizu* in View of *Corn*

Claims 31-34 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Koshimizu* in view of *Corn*. For the reasons that follow, Appellants respectfully submit that claims 31-34 are unobvious over *Koshimizu* in view of *Corn*.

Independent claim 31 recites, *inter alia*, "wherein said second gas is at least intermittently at a higher concentration than said first gas." *Koshimizu* does not teach or suggest such a feature. For example, in Figures 50-53 *Koshimizu* clearly shows that the CF_4 gas is always at an equal or higher concentration than the CHF_3 gas. In addition, there is no teaching or suggestion in *Corn* of such a feature.

Accordingly, claim 31 would not have been obvious over *Koshimizu* in view of *Corn*. Claims 32-34 depend from claim 31 and thus include the limitations thereof. Therefore, claims 32-34 would also not have been obvious over *Koshimizu* in view of *Corn*. Appellants therefore respectfully request that the rejection of claims 31-34 under 35 U.S.C. § 103(a) be overturned.

6. <u>Claim 40 is Unobvious Over *Koshimizu* in View of *Ui*</u>

Claim 40 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Koshimizu* in view of *Ui*. For the reasons that follow, Appellants respectfully submit that claim 40 is unobvious over *Koshimizu* in view of *Ui*.

Claim 40 depends from claim 35 and includes the limitations thereof. As discussed above with respect to claim 35, there is no teaching or suggestion in *Koshimizu* related to the etchant gas being at least intermittently at a higher concentration than the polymer forming gas. In addition, there is no teaching or suggestion in *Ui* of such a feature.

Accordingly, claim 40 would not have been obvious over *Koshimizu* in view of *Ui*. Appellants therefore respectfully request that the rejection of claim 40 under 35 U.S.C. § 103(a) be overturned.

7. <u>Claim 42 is Unobvious Over *Koshimizu* in View of *Benzing*</u>

Claim 42 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Koshimizu* in view of *Benzing*. For the reasons that follow, Appellants respectfully submit that claim 42 is unobvious over *Koshimizu* in view of *Benzing*.

Claim 42 depends from claim 41 and includes the limitations thereof. As discussed above with respect to claim 41, there is no teaching or suggestion in *Koshimizu* related to the non-steady state concentration recited in claim 41. In addition, there is no teaching or suggestion in *Benzing* of such a feature.

Accordingly, claim 42 would not have been obvious over *Koshimizu* in view of *Benzing*. Appellants therefore respectfully request that the rejection of claim 42 under 35 U.S.C. § 103(a) be overturned.

In view of the foregoing, Appellants respectfully request the Board to overturn the Examiner's rejections of the appealed claims.

Dated this 24th day of November 2003.

Respectfully submitted,

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APPENDIX: CLAIMS ON APPEAL

5. A method to control etch profile while etching a microelectronics substrate, the method comprising:

providing an etch chamber and a microelectronics substrate disposed therein; and

pulsing into said etch chamber at least one gas wherein said pulsing imparts a time varying flow rate to said gas for a plurality of periods of said time varying flow rate; wherein the pulsing provides for the alternating steps of:

etching said microelelectronics substrate with said at least one gas; and

forming a deposit with said at least one gas on a side surface of the microelectronics substrate, the deposit preventing additional etching of the side surface of said microelelectronics substrate underneath the deposit;

wherein said pulsing is applied so that said at least one gas does not reach steady state concentration within said etch chamber in said plurality of periods.

6. The method as defined in Claim 5, wherein said etch chamber is associated with a high density etch tool.

7. The method as defined in Claim 5, wherein said substrate is selected from the group consisting of an oxide film, a resist, a multi-layer resist, a metal, a metal alloy, an aluminum alloy, a refractory metal, tungsten, an electrical conductor, and at least one polysilicide.

8. The method as defined in Claim 5, wherein said pulsing is applied so that said at least one gas reaches steady state concentration within said etch chamber in at least one of said plurality of periods.

10. The method as defined in Claim 5, wherein said pulsing is applied at a duty cycle range selected from the group consisting of:

from about 20% to about 80% duty cycle;

from about 30% to about 70% duty cycle; and

from about 40% to about 60% duty cycle.

11. The method as defined in Claim 5, wherein said at least one gas comprises a gas selected from the group consisting of CHF_3, CH_2F_2, a halogenated hydrocarbon, a hydrofluorocarbon, CO, CO_2, O_2, Ar, a fluorocarbon, CF_4, C_4F_8, C_5F_8, BCl_3, Cl_2.

12. The method as defined in Claim 5, further comprising flowing a second gas comprising at least one of the gases nitrogen, oxygen and an inert gas into said etch chamber.

13. The method as defined in Claim 5, wherein said time varying flow rate varying within a range selected from the group consisting of:

between a high flow rate value of about 30 sccm to a low flow rate value of about 15 sccm;

between a high flow rate value of about 27 sccm to a low flow rate value of about 18 sccm;

between a high flow rate value of about 25 sccm to a low flow rate value of about 20 sccm;

between a low flow rate value of about 20 sccm to a high flow rate value of about 30 sccm; and

between a low flow rate value of about 15 sccm to a high flow rate value of about 20 sccm.

14. The method as defined in Claim 13, wherein each of the high and low flow rate values has about the same time duration.

15. The method as defined in Claim 5, wherein said pulsing is controlled with at least one piezoelectric valve.

16. The method as defined in Claim 5, wherein said etching is a process selected from the group consisting of:

an anisotropic self-aligned contact etch; and

an anisotropic high aspect ratio contact etch, wherein the aspect ratio is at least 4 to 1.

17. The method as defined in Claim 5, further comprising, prior to providing said etch chamber, patterning a layered substrate with a photoresist mask to form said microelectronics substrate.

18. The method as defined in Claim 17, wherein said layered substrate comprises an oxide layer and a nitride layer disposed on a silicon layer.

19. The method as defined in Claim 18, wherein said etching halts on said silicon layer.

20. The method as defined in Claim 5, further comprising flowing an etchant gas into said etch chamber.

21. The method as defined in Claim 20, wherein said etchant gas is selected from the group consisting of a polymer forming gas, an etching gas, and a fluorocarbon.

22. The method as defined in Claim 17, wherein said layered substrate comprises at least an oxide layer; the method further comprising flowing an etchant gas into said etch chamber, wherein said etchant gas selectively removes at least a portion of said oxide layer.

23. The method as defined in Claim 5, wherein:

said gas is a protective layer forming gas, wherein the protective layer comprises a polymer;

said microelectronics substrate has at least an oxide layer; and

said gas selectively removes at least a portion of said oxide layer and a vertical profile in said oxide layer.

24. The method as defined in Claim 23, wherein said oxide layer comprises BPSG.

25. The method as defined in Claim 41, wherein said microelectronics structure includes a nitride layer.

26. The method as defined in Claim 25, wherein said nitride layer is at least one of a silicon nitride layer and a silicon oxynitride layer.

27. A method of etching oxide using a polymer, the method comprising:

disposing a patterned semiconductor substrate in a high density plasma etcher, said substrate comprising a silicon layer with a gate stack structure disposed thereon, said gate stack structure being encapsulated by silicon nitride, and layered with an oxide;

providing a hydrofluorocarbon gas into said high density etcher;

selectively removing portions of said oxide by pulsing a fluorocarbon gas; wherein:

said pulsing imparts a time varying flow rate to said fluorocarbon gas for a plurality of periods of said time varying flow rate, wherein said hydrofluorocarbon gas is pulsed in a range from about 0 sccm to about 25 sccm and is at least intermittently at a higher concentration than said fluorocarbon gas;

said hydrofluorocarbon gas removes portions of said oxide; and

said fluorocarbon gas forms a protective layer; and

wherein the pulsing of said fluorocarbon gas causes said hydrofluorocarbon gas to have cyclical concentrations within said high density etcher.

29. The method as defined in Claim 27, wherein said hydrofluorocarbon gas is pulsed into said high density etcher so that the hydrofluorocarbon gas pulses alternate with the fluorocarbon gas pulses and wherein pulsing said hydrofluorocarbon gas imparts a time varying flow rate to said hydrofluorocarbon gas for a plurality of periods of said time varying flow rate.

30. The method as defined in Claim 29, wherein said hydrofluorocarbon gas is pulsed into said high density etcher with at least one piezoelectric valve.

31. A etching method comprising:

forming a photoresist pattern on a microelectronics substrate that includes both an oxide layer and a nitride layer disposed on a silicon layer;

providing an etch chamber and said microelectronics substrate disposed therein;

pulsing into said etch chamber at least one gas suitable for forming a deposit on at least a portion of said microelectronics substrate, wherein:

said deposit is selected from the group consisting of an oxide film, a resist, a multi-layer resist, a metal, a metal alloy, an aluminum alloy, a refractory metal, tungsten, an electrical conductor, polysilicon, and at least one polysilicide;

said at least one gas comprises a gas selected from the group consisting of a halogenated hydrocarbon, and a fluorocarbon;

said pulsing imparts a time varying flow rate to said gas for a plurality of periods of said time varying flow rate;

said pulsing is applied at a duty cycle range selected from the group consisting of:

from about 20% to about 80% duty cycle;

from about 30% to about 70% duty cycle; and

from about 40% to about 60% duty cycle;

said time varying flow rate varies within a range selected from the group consisting of:

between a high flow rate value of about 30 sccm to a low flow rate value of about 15 sccm;

between a high flow rate value of about 27 sccm to a low flow rate value of about 18 sccm;

between a high flow rate value of about 25 sccm to a low flow rate value of about 20 sccm;

between a high flow rate value of about 20 sccm to a low flow rate value of about 30 sccm; and

between a high flow rate value of about 15 sccm to a low flow rate value of about 20 sccm;

etching said microelelectronics substrate with said a second gas during said pulsing, wherein:

wherein said second gas is at least intermittently at a higher concentration than said first gas;

said etching halts on said silicon layer;

said second gas is selected from the group consisting of a polymer forming gas, a polymer etching gas, and a fluorocarbon; and

said second gas selectively removes at least a portion of said oxide layer.

32. The method as defined in Claim 31, wherein said pulsing is applied so that said at least one gas reaches steady state concentration within said etch chamber in at least one of said plurality of periods.

33. The method as defined in Claim 31, wherein said pulsing is applied so that said at least one gas does not reach steady state concentration within said etch chamber in said plurality of periods.

34. The method as defined in Claim 31, further comprising flowing a gas comprising at least one of the gases nitrogen, oxygen and an inert gas into said etch chamber.

35. An etching method comprising:

exposing a substrate to a plurality of gases, wherein at least one of said gases is pulsed and said pulsing imparts a time varying flow rate to said at least one gas for a plurality of periods of said time varying flow rate; and wherein

at least one of said gases comprises an etchant gas selected from the group consisting of a hydrofluorocarbon and a fluorocarbon; and

at least one of said gases comprises a polymer forming gas for depositing a protective layer, wherein said etchant gas is at least intermittently at a higher concentration than said polymer forming gas.

36. The method as defined in Claim 35, wherein

at least one of said gases comprises a gas that modifies the deposition of said protective layer; and

at least one of said gases comprises an etch modifying gas.

38. The method as defined in Claim 35, wherein said gas for depositing a protective layer comprises one gas for depositing a polymer.

39. The method as defined in Claim 36, wherein said gas that modifies the deposition of a protective layer is selected from the group consisting of CO, CO_2, and O_2.

40. The method as defined in Claim 36, wherein said etch modifying gas is selected from the group consisting of BCl_3 and Cl_2.

41. A method to control etch profile while etching a microelectronics substrate, the method comprising:

providing an etch chamber and a microelectronics substrate disposed therein;

pulsing into said etch chamber a carbon containing polymer gas suitable for:

forming a deposit on at least a portion of said microelectronics substrate; and

etching said microelelectronics substrate;

wherein said pulsing imparts a time varying flow rate to said gas for a plurality of periods of said time varying flow rate, thereby causing said gas to alternately form a deposit on at least a portion of said microelectronics substrate and etch said microelelectronics substrate and wherein said pulsing is applied so that said carbon containing polymer gas does not reach steady state concentration within said etch chamber in said plurality of periods.

42. The method as defined in Claim 5, further comprising flowing nitrogen gas into said etch chamber.

43. The method as defined in Claim 5, wherein said layered substrate comprises a thermal oxide layer disposed on a silicon layer.

44. The method as defined in Claim 43, wherein said etching halts on said thermal oxide layer disposed on said silicon layer.

45. A method to provide increased gas flow rate tolerances while etching a microelectronics substrate, the method comprising:

providing an etch chamber and a microelectronics substrate disposed therein;

providing at least one gas for introduction into the etch chamber, the at least one gas capable of both etching the microelelectronics substrate and forming a deposit on a side surface of the microelectronics substrate, wherein use of the at least one gas at a uniform flow rate provides a desired etch profile in the microelectronics substrate at a flow rate selected within a first process window; and

pulsing into the etch chamber the at least one gas wherein the pulsing imparts a time varying flow rate to the gas for a plurality of periods of the time varying flow rate, wherein the pulsing provides for the alternating steps of:

etching the microelelectronics substrate with the at least one gas; and

forming a deposit with the at least one gas on a side surface of the microelectronics substrate, the deposit preventing additional etching of the side surface of the microelelectronics substrate underneath the deposit;

wherein the pulsing enables the selection of flow rates from within a second process window that is larger than the first process window while still providing the desired etch profile in the microelectronics substrate.

46. The method as defined in Claim 45, wherein the pulsing is applied so that the at least one gas does not reach steady state concentration within the etch chamber in the plurality of periods.